Exhibit 13 - Representative Task Orders (RTOs)

RTO 1: Venus1 Mission Flight Dynamics Analysis (Venus1)

RTO 2: Flight Dynamics Facility Navigation Operations

RTO 3: Hypothetical Near-Earth (HNE) Mission

RTO 1: Venus1 Mission Flight Dynamics Analysis (Venus1)

I. Summary of Work

The Navigation and Mission Design Branch (NMDB) will provide primary flight dynamics support to the Venus1 mission. Venus1 is a Venus orbiter and will launch in 2019. This task will support NMDB in the areas of orbit determination (OD) analysis, model and system development, trajectory and mission design, maneuver planning, and tools development. Particular emphasis will be in support of the propellant budget analysis and validation and verification of FD requirements.

II. Period of Performance

The contractor shall perform the work for this task modification between January 11, 2015 and January 10, 2019.

III. Subtask Descriptions

The task will consist of several separate but related analysis and tool development subtasks. These subtasks are not functionally separate but are simply the primary work items. Separate cost tracking is not required. Other work items are entirely possible and are in fact expected. In the course of performing each subtask listed and described herein, the contractor shall expect to participate in weekly status meetings. The contractor shall maintain and follow a CMMI Level 2 compliant process for any software development efforts. For all subtasks the contractor shall support the TM as needed including trade space analysis, tools and techniques development, reporting to other project groups, and results documentation.

For each Subtask area, the contractor shall develop and maintain a repository which includes current and past documentation, as well as software code and scripts.

Subtask 1: Navigation/Orbit Determination

> In this subtask, the contractor shall use existing tools to analyze the mission orbit determination requirements. Items required for this subtask are an N-Plate SRP model, Venus gravity and atmospheric density (drag) models, the ability to determine of the effects of modeled and unmodeled momentum management, the ability to model ACS maneuvers, and the ability to solve for SRP estimation parameters. Improvement in software, procedures and processes may be proposed and implemented if needed.

Subtask 2: Launch Window, Trajectory Design, Delta V

> In this subtask, the contractor shall execute launch window and trajectory analysis using existing tools and techniques while also proposing new methods if needed. Estimation of the deterministic and statistical delta v parameters is required. Frequent re-runs of analysis are likely to support project level requests. Analysis items may include requirements verification and trade studies for relaxing requirements, propulsion system modeling, and error analysis.

Subtask 3: Ground System Support

In this subtask, the contractor shall analyze tracking network (ground and NASA Space Network) contact (communications and tracking) opportunities while Venus1 is still attached to the launch vehicle (powered flight) as well as after separation. Trade space studies may be required to characterize what communication assets are required to cover all critical events during all phases of the mission. Support may include participation in Ground Systems meetings and document review, and in particular interface development and definition.

IV.   Deliverable Items and Schedules

At a minimum, the contractor shall deliver the items specified below.

Deliverable	Due Date
Orbit Determination analysis results (Subtask 1)	Initial delivery: May 20, 2015 Final delivery: October, 10, 2018
Launch Window, Trajectory Design, Delta V analysis results (Subtask 2)	Initial delivery: May 20, 2015 Final delivery: October, 10, 2018
Ground System analysis results and interface documentation input (Subtask 3)	Initial delivery: July 20, 2015 Final delivery: September 10, 2018
Routine/Misc. Task Deliverables	As Required
Task meetings	Weekly

V. Configuration Management

Systems and documents shall be covered under the existing Venus1 Level 2 compliant Configuration Management Plan. Compliance with additional CM plans associated with other missions relevant to the task may also be required. The contractor shall provide and maintain an online repository, accessible to the TM from onsite at GSFC, for maintenance of current and historical versions of all products resulting from this task.

VI.   Facilities

Appropriate Information Technology devices to support the analyses, specification development, and report development are required. It shall be the contractor's responsibility to provide and set up local workstations and network connections at the contractor's off-site facilities as required, and to install any required tools and utilities on the contractor's equipment.

VII.   Risk Management and Best Practices

The contractor shall manage schedule, cost, and technical risk through monitoring and reporting of progress and performance metrics, identifying issues well in advance of negative consequences, and taking corrective actions when appropriate.

VIII. Government Furnished Facilities, Equipment, Software, and Other Resources

The Government will provide accounts and passwords to government-furnished workstations where existing versions of various relevant software packages shall be maintained. It shall be the contractor's responsibility to complete any GSFC required security-related training courses.

IX. Work Location

This work shall be performed primarily at the contractor's facility, but the contractor may be required to perform some work at the Goddard Space Flight Center.

X. Reporting Requirements

The contractor shall report status in person or via teleconference to the TM or designated alternates on a weekly basis. Reports shall include informal presentation of interim results, status of development activities, and action item status. The contractor shall provide all reports at least one day in advance of the weekly meeting via email, and maintain an email distribution list with the concurrence of the TM. The contractor shall also support the TM in the preparation of status reviews for internal and external funding agencies. The contractor shall deliver all documents in portable document format (PDF) electronic form to the GSFC NMDB online library, as directly by the TM.

XI. Security Requirements

This task shall comply with IT security requirements as documented in the FDF IT security plan for all systems located in the FDF (if any). FDF systems shall be maintained under the FDF Sustaining Engineering Task. Systems located outside of the FDF shall be covered under the Code 590 security plan and the Code 590 sustaining engineering support or the contractor sustaining engineering support depending on system location.

XII. Rights

This SOW shall adhere to the RIGHTS IN DATA – special works (FAR 52.227-17) as modified by NFS 1852.227-17.

XIII. References

None.

<div align="center">(END OF REPRESENTATIVE TASK ORDER)</div>

RTO 2: Flight Dynamics Facility Navigation Operations

I. Summary of Work

This task order statement of work (SOW) describes hypothetical navigation support scenarios, based on potentially real requirements, within the Flight Dynamics Facility (FDF).

The support required by this SOW covers five areas, described in detail in Section V of the SOW below, including (a) mission preparation, launch and early orbit support, (b) routine operations and mission analysis, (c) ground station certification and operational supports, (d) post-maneuver orbit determination, and (e) software testing.

The contractor shall expect to work closely with the Government's Task Monitor (TM) for this task, and to work with NASA organizations and contractor personnel as well as NASA's partners in other Government agencies, industry, and academia when needed to accomplish the technical objectives of the task. The nature of the operations work in this task requires that the contractor be prepared to provide support for unplanned spacecraft activities or anomalies.

Details of the work by subtask are provided below. This work will generally require the contractor to utilize a mix of GSFC in-house and commercial-off-the-shelf orbit determination and mission planning software in performance of the work items. The contractor may, in some situations, propose the use of their own proprietary software. The technical and cost advantage to the Government should be clearly justified.

II. Period of Performance

The period during which the work for this task shall be performed begins January 1, 2015 and ends on December 31, 2016.

III. Work Location

All (100%) of this work is expected to occur at the FDF at Goddard Space Flight Center (GSFC).

IV. Government Property

The Government will provide the facility and facility services for mission support functions performed onsite at GSFC. Within these onsite facilities, the Government will provide office and workstation furniture that are required to provide support for the necessary mission elements and its ground support elements.

A summary of other Government-furnished equipment that may be applicable to this task is available in Attachment I of the contract.

V. Specific Tasks

The contractor shall perform the following specific tasks during the period specified in Section II.

A. *Mission Preparation and Launch and Early Orbit Support for Earth Science Explorer (ESE)*

The ESE spacecraft is scheduled to launch on January 1, 2016 at 12:00 pm Eastern Standard Time into a 600 km circular polar orbit. After spacecraft separation, the Tracking Telemetry, and Command (TTC) functions will all be conducted through the Space Network (SN). Differenced One-Way Doppler (DOWD) data will be provided to the FDF via existing interfaces with the SN. The FDF is required to support navigation functions for this mission from launch through launch + 14 days, at which point the Mission Operations Center (MOC) will use Global Positioning System (GPS) data for navigation purposes and FDF services will no longer be required.

In this subtask, the contractor shall perform the following activities:

- Prelaunch preparations for one year prior to launch, including analysis testing, simulations, training, documentation, and mission reviews as needed.
- Provide SN view period products, to allow the scheduling of SN resources.
- Launch day support, including a product delivery at launch+6 hours. This delivery includes definitive and predictive ephemerides for the MOC and acquisition data to the SN. The required accuracy is best available.
- Daily product deliveries at 1:00 pm Eastern Standard Time from launch+1 day through launch+14 days. Each of these deliveries includes definitive and predictive ephemerides for the MOC and acquisition data to the SN.
- Perform verification and validation of the GPS navigation system in the MOC from launch+10 days through launch+14 days.

- Note that any FDF support of the launch vehicle is not included in this subtask.

B. *Routine Operations and Mission Analysis for Lunar Knowledge Gatherer (LKG)*

The LKG spacecraft is currently operating in a low-lunar orbit (altitude less than 100 km) and plans to continue operating in that orbit throughout the two-year period of this task. Two-way ranging and Doppler tracking data for LKG is provided to the FDF via the Deep Space Network (DSN) and the Universal Space Network (USN). The FDF is required to perform navigation functions on a daily basis, providing products to the DSN, USN, and the LKG MOC. In addition, the FDF is required to provide contingency support as needed.

In this subtask, the contractor shall perform the following activities:

- Provide acquisition data to the DSN and USN by 11:00 am (Eastern Time) daily.
- Provide a set of fifteen mission navigation products, as defined by LKG documentation, by 11:00 am (Eastern Time daily.
- Provide any navigation support requested by the MOC for contingencies, if needed.
- Complete an analysis to demonstrate how to reduce tracking costs to the LKG mission while meeting the LKG navigation requirements. This analysis should consider the use of DSN versus USN passes, the number and timing of tracking passes per day, and the duration of each individual tracking pass. The output of this analysis will be a technical report and presentation, due on July 1, 2015.

C. Ground Station Certification and Operational Support for Daytona Tracking Station (DTS)

The Near Earth Network (NEN) is building a new ground station, DTS, to support NASA missions. The DTS is required to be operational and certified for two way Doppler and ranging support of LKG by January 1, 2016. The FDF is required to develop a certification plan for DTS, provide the tracking data evaluation function for the certification effort, and to provide ongoing tracking data evaluation after the station is operational.

In this subtask, the contractor shall specifically perform the following activities:

- Develop a plan for the certification of DTS two-way ranging and Doppler capabilities.
- Provide all tracking data evaluation support needed for the DTS certification.
- Provide ongoing tracking data evaluation after DTS is operational.

D. Post Maneuver Orbit Determination for the Geostationary Scientific Payload (GSP)

The GSP spacecraft conducts solar science from geostationary orbit and is expected to operate continuously throughout the two year period of this task. The FDF is required to provide navigation support after any stationkeeping maneuvers which are planned by the GSP MOC and upload to the spacecraft. These stationkeeping maneuvers occur approximately once every seven days. These maneuvers can be planned for any day of the week at any time of day. The FDF often receives only two hours notice of an upcoming maneuver and is required to produce a navigation solution within four hours after the maneuver.

In this subtask, the contractor shall specifically perform the following activities:

- Provide an ephemeris product to the GSP MOC four hours after any stationkeeping maneuver using the best available navigation solution.

E. Operations Testing of the Satellite Orbit System (SOS)

The SOS is new software that has been developed by the Government to produce a variety of navigation products and will be used in the FDF to produce products for FDF customers. The software will be available to start operations testing on October 1, 2015. The SOS is required to be operational in the FDF by October 1, 2016.

In this subtask, the contractor shall perform the following activities:

- Develop an SOS operations testing plan including needed reviews, schedule of activities, required resources, and associated budget.
- Complete SOS operations testing, conducting reviews as necessary

VI. Travel

Non-local travel is not required for this task. The contractor may propose non-local travel for technical meetings or other activities that enable the completion of tasks listed in this SOW.

VII. Reporting Requirements

The contractor shall report status to the Task Monitor (TM) and the FDF Operations Director on a daily basis via email. The contractor shall propose the process by which these Government representatives are apprised of the status of open actions and concerns on this task and the process by which they are tracked to closure. The contractor shall support the preparation of materials for technical discussions and presentations when needed. The contractor shall compile the results of technical analyses into technical reports for archival purposes and when appropriate, into conference-quality papers for external audiences.

VIII. Security Requirements

When working inside the GSFC perimeter or online any GSFC networks, the contractor shall maintain compliance with all GSFC Information Technology (IT) security guidelines. Access to classified information is not required for this task.

IX. Risk Management Requirements

The contractor shall perform risk management according to all applicable NASA policy directives, including, but not limited to, the applicable versions of NPR 8000.4 and/or NPR 7120.5.

X. Electronic Information Technology Compliance

The contractor shall maintain compliance with all applicable NASA policies concerning electronic and information technology accessibility, including, but not limited to, 36 CFR Part 1194, Section 508 of the Rehabilitation Act of 1973, etc., or document exemptions based on NASA-approved rationale and documentation, including but not limited to NASA Procurement Information Circular 05–01.

(END OF REPRESENTATIVE TASK ORDER)

RTO 3: Flight Dynamics Support for the Hypothetical Near-Earth (HNE) Mission

I. Summary of Work

This task order statement of work (SOW) describes the research, analysis, engineering, and operations support necessary to perform all flight dynamics functions for the Hypothetical Near-Earth (HNE) mission. Since the full lifecycle of a typical mission may exceed the nominal length of the FDSS contract, for purposes of this RTO, we assume that HNE is already being developed and is currently in Phase C/D (design completed, implementation and integration & testing are underway and launch is within 20 months). Bidders should assume that a prior task or tasks previously provided the mission design and the operations concept for the Mission Operations Center and ground data systems.

HNE consists of two three-axis stabilized nadir-pointing spacecraft (HNE-1 and HNE-2) that will perform all attitude determination and control functions autonomously onboard and perform coincident imaging in support of earth science as part of the Earth Observation System (EOS). Project and operations management will be provided by GSFC, and science management by an external Principal Investigator. The HNE spacecraft were designed and are being developed, manufactured, integrated and tested in-house at GSFC along with the spacecraft carrier assembly (SCA) that carries the HNE spacecraft during launch and early orbit.

The HNE spacecraft and carrier assembly are due to launch on March 15th 2017 12:00:00 UTC aboard an Atlas V with a Centaur upper stage. The daily launch window is 30 minutes in duration and lasts until the summer solstice season (assumed to begin on June 15th) when launch is precluded by shadow constraints.

After the burnout of the upper stage, the SCA, which stays attached to the Centaur, dispenses one HNE spacecraft and then dispenses the other HNE spacecraft 20 minutes later. Each spacecraft stays in its insertion orbit for 5 days for initial checkout then begins its ascent maneuvers into the mission orbit. The HNE science goals requires that HNE-1 and HNE-2 assume a sun-synchronous 705 km altitude orbit with 0.5 minutes difference in mean-local-time and with 10 seconds of time difference in equator crossing.

Once the mission orbits are achieved, the HNE spacecraft must maintain precise orbits relative to each other, while minimizing station-keeping maneuver frequency. HNE will utilize GSFC's GEONS[1] software to perform onboard orbit determination using data and observables from an onboard transceiver. This transceiver provides inter-satellite and ground communications, and provides orbit determination observables from Global Positioning System (GPS), Track & Data Relay Satellite (TDRS), and Universal Space Network (USN) stations, as well as inter-spacecraft observables. HNE must also perform conjunction predictions and perform collision avoidance maneuvers, as circumstances dictate.

The contractor shall expect to work closely with the Government's task monitor (TM) for this task, and to work with NASA personnel as well as NASA's partners in other Government agencies, industry, and academia in the accomplishment of the technical objectives of the task.

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[1] http://techtransfer.gsfc.nasa.gov/ft-tech-GEONS.html

Because of the non-standard nature of the work in this task, work priorities and objectives may change as project requirements evolve. Therefore, the contractor shall be prepared to provide timely support of unplanned high-priority actions resulting as circumstances dictate.

Details of the work by subtask are provided below, and should be considered as a baseline. This work will generally require the contractor to utilize a mix of GSFC in-house and commercial-off-the-shelf orbit determination and mission planning software in performance of the work items. The contractor may, in some situations, propose the use of their own proprietary software. The technical and cost advantage to the Government should be clearly justified.

II. Period of Performance

The period during which the work for this task shall be performed begins July 15, 2015 and ends on July 31, 2017. Figure 1 shows a high-level schedule and the external milestones that shall be supported by the task.
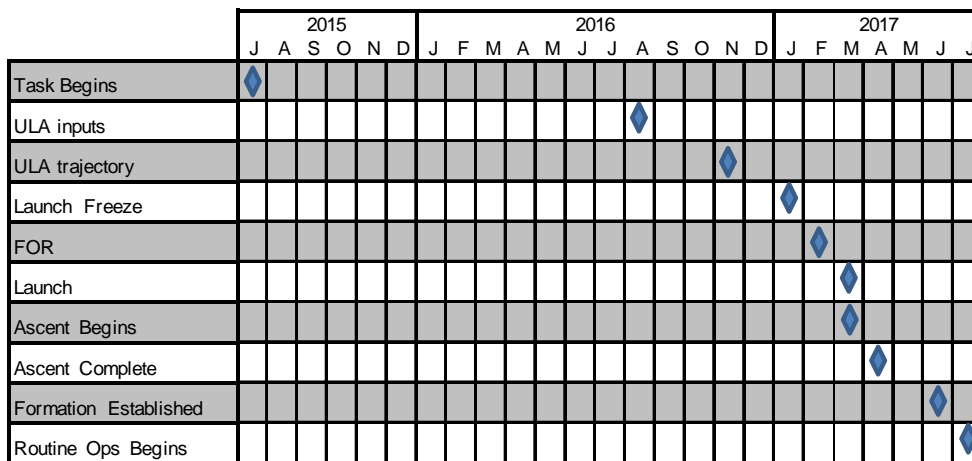
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Figure 1: HNE high-level schedule.

III.   Work Location

Approximately 35% of this work is expected to occur at operational facilities at Goddard Space Flight Center (GSFC). The remaining portion of the work shall be done at the contractor's facility.

IV.   Government Property

The Government will provide the facility and facility services for mission support functions performed onsite at GSFC. Within these onsite facilities, the Government will provide office and workstation furniture that are required to manage and operate the spacecraft and its ground support elements.

A summary of other Government-furnished equipment that may be applicable to this task is available in Attachment I of the contract.

V. Specific Tasks

The contractor shall perform the following specific tasks consistent with the high-level schedule as shown in Figure 1.

A. Mission Design – Cycle P

In this subtask, the contractor shall start with the current Cycle P outputs from United Launch Alliance (ULA). These outputs consist of:

- the injection state as a function of time in the daily launch window,

- a launch vehicle covariance matrix that characterizes the launch vehicle dispersions,

- the coverage of critical events by USN and Space Network (SN) assets,

- the angle history of the Sun with respect to the SCA body axes from fairing jettison to spacecraft separation.

The contractor will analyze Cycle P data against the mission requirements and prepare an assessment that will be documented in deliverable D1.

B. Contingency Analysis – Cycle P

In this subtask, the contractor shall perform the following contingency analysis activities.

1. Analyze the Cycle P Monte Carlo results provided from ULA on minimum separation of HNE-1 and HNE-2 from the launch vehicle based on the planned Contamination and Collision Avoidance Maneuver (CCAM).

2. Update the delta-V budget to reflect Cycle P launch vehicle dispersions.

3. Analyze the strategies to delay the ascent maneuvers and update the delta-V budget appropriately

4. Analyze moving ascent maneuvers to be in contact with the USN or SN in the event the scheduled asset is unavailable. Update the delta-V budget appropriately.

These analyses will be documented in deliverable D2.

C. Launch Window Analysis – Cycle P

The HNE daily launch window is defined as a set of launch and ascent trajectories sampled at 30 second intervals over a 30 minute span. The trajectories are to be generated using the HNE automated launch window system where each sample takes 10 minutes to produce. For the HNE launch, ULA requires 3 weeks of launch window cases at a time and that the window shall be extended with an additional week for every week of delay. In support of this subtask, the contractor shall:

1. Calculate an initial 2 week launch window with an analysis of the corresponding delta-V and determine which trajectories satisfy the mission requirements.

2. Develop a strategy to extend the launch window in the event of a launch delay.

3. Support the generation and dissemination of data in support of Launch Collision Avoidance (COLA) (GPR 8000.1)

These analyses will be documented in deliverable D3.

D. Mission Design – Cycle Q

In this subtask, the contractor shall distill the work done in subtasks A-C to produce the final input to ULA, which will be documented in deliverable D4.

E. Simulations and Operational Preparation

In this subtask, the contractor shall develop launch and early orbit simulation materials to be used in conjunction with L&EO simulation 1, 2, and 3 (see Table 1). These materials will include operations handbooks, procedures, and operational scripts which are documented in deliverables D5-D7.

F. Operational Support

In this subtask, the contractor shall provide flight dynamics services to support launch readiness, launch and early orbit, and handover to routine operations. Specific work elements include the following.

1. Flight Operations Review

For this work, the contractor shall develop all materials for and shall support the Flight Operations Review (FOR) 30 days before launch.

2. Launch and Early Orbit (L&EO) Orbit Determination

The contractor shall perform launch and early orbit support for HNE-1/HNE-2 orbit determination using the existing processes and software in the FDF.

3. Ascent Support

The contractor shall perform the following activities in support of the HNE-1/HNE-2 ascent:

- Initial replanning of the ascent profile (impulsive maneuvers) using a definitive L&EO orbit determination state

- Finite planning, reconstruction, and calibration of the each ascent maneuver.

- Generation of predictive products based on each maneuver plan update.

4. Onboard Navigation

For this work element, the contractor shall support initial checkout of the onboard GEONS navigation solutions (after completion of ascent through establishment of the formation) against ground-based solutions and will monitor performance until task closeout.

5. Closeout Activities

For this work element, the contractor shall develop handover materials to transition routine flight dynamics support to the Flight Operations Team (FOT). These materials will be documented in deliverable D8. The contractor shall write a post launch report (deliverable D10) documenting the launch support activities and lessons learned. The contractor shall write a closeout report (deliverable D12) as the final deliverable.

VI. Deliverable Items and Schedules

The contractor shall, at minimum, deliver the following items according to the schedule shown.

Table 1: HNE Mission Deliverables		
Deliverable Item	*Description*	*Delivery Date*
D1	Mission Design – Cycle P Assessment	11/1/15
D2	Contingency Analysis Report	2/1/16
D3	Launch Window – Cycle P	8/30/16
D4	ULA Trajectory Inputs	8/15/16
D5	L&EO Sim 1	9/15/16
D6	L&EO Sim 2	12/15/16
D7	L&EO Sim 3	2/15/17
D8	FOR Support Materials	2/15/17
D9	Routine Task Reporting (tracked as deliverable D9a, D9b, etc.)	Weekly, Monthly, Annually
D10	Post Launch Report	7/1/17
D11	FOT Handover Materials	7/15/17
D12	Task Closeout Report	7/31/17

VII. Travel

Key contractor personnel shall attend all major project reviews, as specified in NASA Procedural Requirement (NPR) 7120.5E, which will be held within the GSFC local area. In addition, the contractor shall plan to send key personnel to at least three face-to-face meetings at the Principal Investigator's (PI) facility in Huntington Beach, CA, in conjunction with mission status reviews.

VIII. Reporting Requirements

The contractor shall report status to the TM or designated alternates on a weekly basis. Reports shall include, but are not limited to: informal presentation of interim results, status of development activities, and action and risk item status. The contractor shall provide written summaries of meeting discussion items within not more than one day after each weekly meeting via email to the TM. The contractor shall also support the TM in the preparation of status reviews for internal and external agencies. The contractor shall be expected to periodically compile results from this task into technical papers of archival journal quality for presentation at technical conferences and submission to professional journals. The contractor shall deliver all documents in portable document format (PDF) electronic form to the TM. Digital storage media in DVD format containing all numerical results and all input data relevant to reproducing the results shall accompany all analysis reports.

IX. Security Requirements

When working inside the GSFC perimeter or online any GSFC networks, the contractor shall maintain compliance with all GSFC IT security guidelines. Access to classified information is not required for this task.

X. Risk Management Requirements

The contractor shall perform risk management according to all applicable NASA policy directives, including, but not limited to, the applicable versions of NPR 8000.4 and/or NPR 7120.5.

XI. Electronic Information Technology Compliance

The contractor shall maintain compliance with all applicable NASA policies concerning electronic and information technology accessibility, including, but not limited to, 36 CFR Part 1194, Section 508 of the Rehabilitation Act of 1973, etc., or document exemptions based on NASA-approved rationale and documentation, including but not limited to NASA Procurement Information Circular 05–01.

(END OF REPRESENTATIVE TASK ORDER)